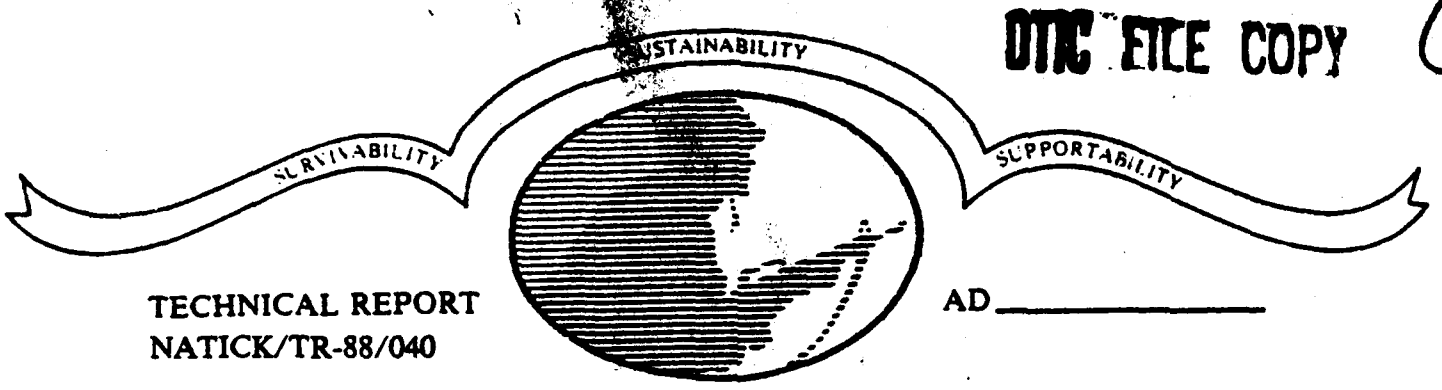

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FUTURE TRENDS IN COMBAT RATION DEVELOPMENT: AN APPLICATION OF THE DELPHI TECHNIQUE

BY

STEPHEN A. REI

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UNITED STATES ARMY NATICK
RESEARCH, DEVELOPMENT AND ENGINEERING CENTER
NATICK, MASSACHUSETTS 01760-5000

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One of the tasks in Systems Analysis of Combat Food Service Requirements in Army 21 was to develop several feeding concepts for future military missions. To facilitate the acceptance of these concepts, recent trends in combat ration development were identified. The method selected to identify these trends was the Delphi technique. This report documents the results of three surveys, which collectively form the Delphic poll.

Based on the aggregate survey results, the following recommendations are made:

- customer acceptance should be integral in all new ration development programs;

- ration characteristics should be prioritized according to the intended user of the ration, intensity of action, duration, and resupply; (continued)

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BLOCK 19 ABSTRACT (continued)

- rations should become mission specific with nutritional levels optimized to anticipated levels of physical activity within logistic constraints; and

- allocation of research and development effort should be balanced between new ration development (36%), improving existing rations (33%) and basic food research (31%).

Keywords: military rations; food processing; food preparation; & analysis; nutrition

PREFACE

During fiscal year 1983, the Directorate for Systems Analysis and Concept Development (DSACD)* at the U.S. Army Natick Research and Development Center** initiated an investigation to determine the Combat Food Service Requirements in Army 21. This work was authorized under the Department of Defense Food and Nutrition Research and Engineering Program, Project 1L162724AH99, Joint Services Food/Nutrition Technology, Systems Analysis of Combat Food Service Requirements in Army 21. The work was performed from January 1985 to September 1985. The purpose of this project was to develop an optimal combat food service system concept to focus research and development efforts in military rations and food systems. This report documents a Delphic poll conducted to forecast trends in combat ration development.

The author is indebted to the following individuals for their contributions to this effort:

Mr. Joseph Smith and Ms. Jane Simpson, DSACD, for their assistance in developing, evaluating, and executing the three surveys documented in this report; and Ms. Maura Severance and Ms. Maureen Savage, DSACD, for their excellent secretarial support throughout the project.

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*DSACD, through an FY1985 reorganization, merged resources with other Natick elements to form the Advanced Systems Concepts Directorate (ASCD).

**The U.S. Army Natick Research and Development Center was recently renamed the U.S. Army Natick Research, Development and Engineering Center (Natick).

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INTRODUCTION

Army 21 is the Army's warfighting concept for the early 21st century. The purpose of Army 21 is to serve as the basis for evolutionary development in all functional areas. Army 21 will also focus research and development, establish the framework for future doctrine and force structure, identify personnel and training imperatives, and serve as the basic warfighting concept for Army Long Range Planning Guidance (ALRPG).

One of the tasks in Systems Analysis of Combat Food Service Requirements in Army 21 was to develop several feeding concepts for future military missions. To facilitate the acceptance of these concepts, recent trends in combat ration development were identified. The method selected to identify these trends was the Delphi technique. This report documents the results of three surveys, which collectively form the Delphic poll.

METHODOLOGY

When the ancients wanted to anticipate the future, they consulted with the oracle at Delphi. If she still were in residence, we too could consult her on the food service requirements for Army 21.

One technique used extensively by modern-day prognosticators is known as the Delphic poll, named in honor of the ancient oracle. Delphic polling begins with a survey of experts' opinions regarding the probability of occurrence and the time frame for hypothetical scenarios. The responses to the initial survey are used selectively as feedback in a second polling of the same experts. The objective of the Delphic poll is to reach a consensus among a group of experts on a given subject; in this case, ration development approaching the Army 21 time frame. The advantages of the Delphic method are: (a) the response distributions from the subsequent poll are typically less variable, and less ambiguous, than those of the first; and (b) the group consensus responses have been found to accurately forecast the future.*

The survey population was defined as the workforce at NRDEC involved with combat rations. The survey sample consisted of 23 individuals in the Behavioral Science, Biological Sciences, and Physical Sciences Divisions of the Science and Advanced Technology Directorate; the Food Technology and Systems Engineering Divisions of the Food Engineering Directorate; the Special Assistant to the Department of Defense Food Program; and the Director, Nutrition and Research, U.S. Army Research Institute of Environmental Medicine. Also, members of ASCD participated in pretests of the various surveys.

Because of the extended sampling period, estimated at 45 to 60 days, participants were questioned on their availability for the entire test period. The original sample size was set at 25, but 2 potential respondents indicated that they would not be available for the entire period; hence, the sample size was reduced to 23.

Copies of the three surveys are included as Appendixes A, B, and C.

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*Linstone, H.A., and Turoff, M. (Eds.). The Delphi Method: Techniques and Applications, 1975.

TRENDS IN COMBAT RATION DEVELOPMENT PART I: RESULTS AND DISCUSSION

Ration Preservation

Scenarios 1, 3, 5, 7, and 9 of the first survey (see Appendix A) all address issues relating to combat ration preservation. These scenarios are listed in Table 1 below.

TABLE 1. Ration Preservation Scenarios.

Question	Scenario
1	A new food additive plays a dominant role in the preservation of combat rations.
3	Freeze dehydration becomes the primary means of producing shelf stable foods.
5	Irradiation becomes a widely used method of producing shelf stable foods.
7	Aseptic packaging becomes the preferred method of producing both liquid and particulate shelf stable products.
9	New technology permits refrigeration/freezing to become the dominant means to preserve combat rations.

The evaluations of this group of scenarios were among the most optimistic in the survey. Most respondents indicated that a new food additive would become dominant in the future (Scenario 1). The time frame selected most frequently for this development was 1990 to 1994. Given the tremendous expansion of the biotechnology field, it would not be unreasonable to assume that increased research activity could produce dramatic results in the future.

Judging from the evaluations of Scenario 3, freeze dehydration is unlikely to become a primary means of producing shelf stable foods; more respondents selected the "never" time frame than all of the other time frames combined. Since freeze dehydration is energy intensive, all products produced are very expensive. Therefore, unless technological advances make the process more efficient, it appears that freeze dehydration is not likely to become a primary preservation method for combat rations.

Evaluations of Scenario 5 indicated irradiation is not expected to become a widely used method to produce shelf stable foods until the 1995 to 1999 time frame. While irradiation technology has been available for years, government regulations have restricted its use in foods to only a few products. Commercial

food irradiation firms have petitioned the Food and Drug Administration (FDA) to relax restrictions on a number of food products. Industry proponents expect widespread use of irradiation immediately after FDA approval.

According to evaluations of Scenario 7, aseptic packaging should become the the preferred method of producing both liquid and shelf stable products during the 1995 to 1999 time frame. These results undoubtedly reflect the increased use of aseptic packaging of liquids by fruit juice producers and the long expected introduction of aseptically processed particulates by the end of the year.

Scenario 9 proposed that a new technology would allow combat rations to be preserved by refrigeration/freezing. An overwhelming majority of respondents selected the "never" response in evaluating this scenario. At the current time, providing refrigeration/freezing in combat situation is a logistic nightmare because of the considerable amount of electrical power required which must be supplied by a generator in the field. This response suggests that there is little possibility of a breakthrough in solar power that could make refrigeration/freezing a viable method for preserving combat rations.

The results of these evaluations are depicted in Figure 1.

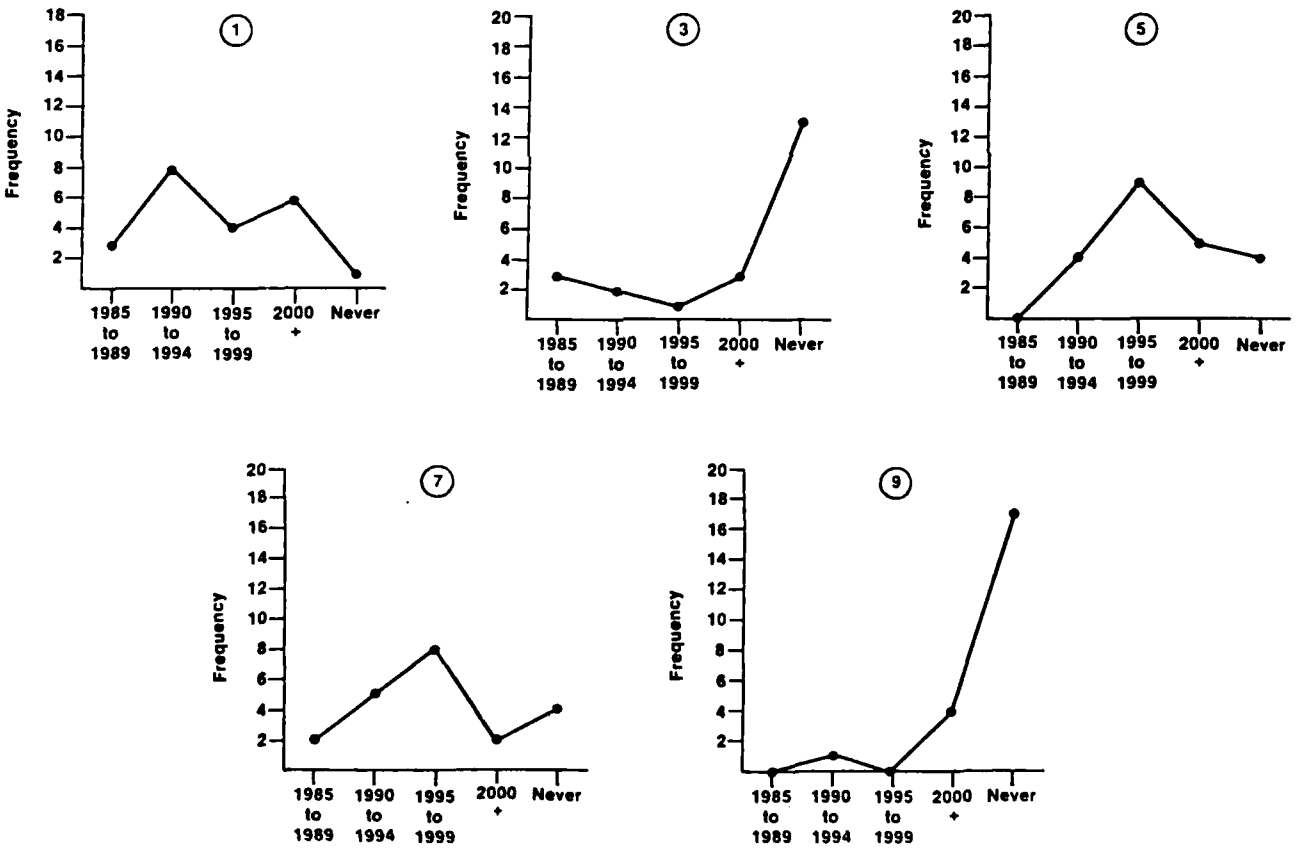

Figure 1 — Evaluations of Ration Preservation Scenarios

Combat Food Service

Scenarios 2, 8, 13, 14, and 15 all address issues relating to combat food service. These scenarios are listed in Table 2 below.

TABLE 2. Combat Food Service Scenarios.

Question	Scenario
2	Highly motivated soldiers view rations as "fuel for the battle", negating the need for highly acceptable foods.
8	The tray pack becomes obsolete for consolidated field feeding.
13	Behavior modifying substances are incorporated into rations to improve battlefield performance.
14	Technological advances make the MRE ration obsolete.
15	Battlefield water supply precludes the use of dehydrated rations in field feeding.

Specifically, these scenarios asked which rations would remain viable, when rations should be used, and what needs rations should fulfill. The evaluations for this group of scenarios were more pessimistic than those in previous groups.

In evaluating Scenario 2, respondents were asked indirectly if rations would ever be viewed solely as nutritional sustainment, rather than being perceived as food. The overwhelming selection of the "never" response stresses the relationship of a ration's resemblance to "real" food and its acceptability.

Scenario 8 asked respondents when the tray pack would become obsolete for consolidated field feeding. Since many respondents have been involved with the tray pack, its development and testing, an optimistic evaluation was expected. Most respondents selected the 2000+ time frame, indicating that the tray pack should have a life expectancy beyond 20 years.

Scenario 13 addressed the subject of adding substances to rations to modify or enhance performance. To date, regulations set forth by the Office of the Surgeon General forbid the use of drugs in foods or rations. Although most respondents selected the 2000+ time period for this scenario, responses were distributed across all time periods, indicating that some individuals believe that drugs or other substances may eventually be added to rations.

Scenario 14 asked respondents to predict when technological advances would make the MRE obsolete. Results indicated obsolescence for the MRE sometime beyond the 2000+ time period. Once again, because many respondents have worked with the MRE, either directly or indirectly, and optimistic response was expected.

Battlefield water requirements were addressed in Scenario 15. Specifically, respondents were asked whether water supply would ever preclude the use of dehydrated rations in combat feeding. The subject of water is critical because potable water is usually in short supply on the battlefield. Since dehydrated rations require the addition of water, their extensive use increases the demand for a scarce commodity on the battlefield. Most respondents do not view the additional water requirements as a problem, however, as the "never" response was selected most often. With dehydrated rations the weight and cube of rations may be reduced by 50-70% in the logistic chain and water supplied locally, while "wet pack" rations increase the logistics burden, but rely less on local water supply.

The results of this second group of evaluations are shown in Figure 2.

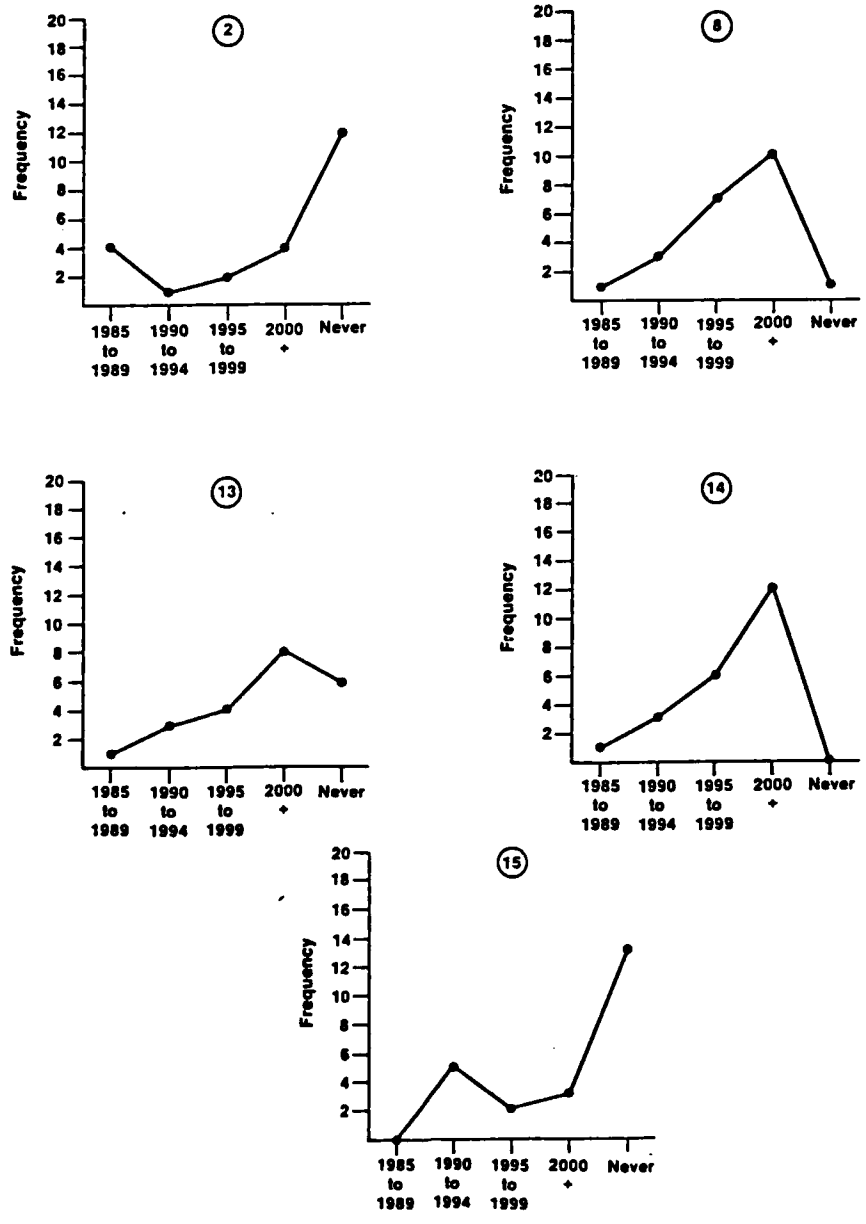

Figure 2 — Evaluations of Combat Food Service Scenarios

Combat Ration Development

Scenarios 4, 6, 10, 11, and 12 all address issues relating to combat ration development. The evaluations for this group of scenarios indicated that food sources, forms, and expectations are not likely to change drastically in the near future. These scenarios are listed in Table 3.

TABLE 3. Combat Ration Development Scenarios.

Question	Scenario
4	All combat rations are highly engineered and do not resemble the common foods of today.
6	A newly developed drug substantially lowers the daily requirement for calories.
10	Concentrated nutrient tablets replace daily meals.
11	Reducing weight and cube is no longer the focus of research and development efforts for combat rations.
12	Food consumption in NBC environments becomes the driving force behind future ration development.

Scenario 4 asked respondents when all rations will be highly engineered or not resemble the common foods of today. Most respondents indicated that all rations will become highly engineered during the 2000-time period.

The development of a drug that substantially lowers the daily requirement for calories was proposed in Scenario 6. An overwhelming majority of respondents selected the "never" response, indicating that such a development is unlikely.

The replacement of daily meals by concentrated nutrient tablets was proposed in Scenario 10. Respondents selected the "never" response by an overwhelming majority, indicating that such tablets are not likely to be developed.

A primary goal of ration development has been to reduce weight and cube; Scenario 11 asked respondents to predict when a new goal will become the focus of ration research and development. The most frequently selected response was "never", indicating that reducing weight and cube will continue to be the focus of ration research and development for the near future.

Scenario 12 proposed that food consumption in an NBC environment would become the driving force behind ration development. A majority of respondents selected the 1985 to 1989 time frame, the most near-term response available. The second most frequent response was "never", only one selection behind.

Overall, the scenarios in this group were the most controversial in the survey; thus, the variety of responses were not surprising. Actual evaluations of these scenarios are presented in Figure 3.

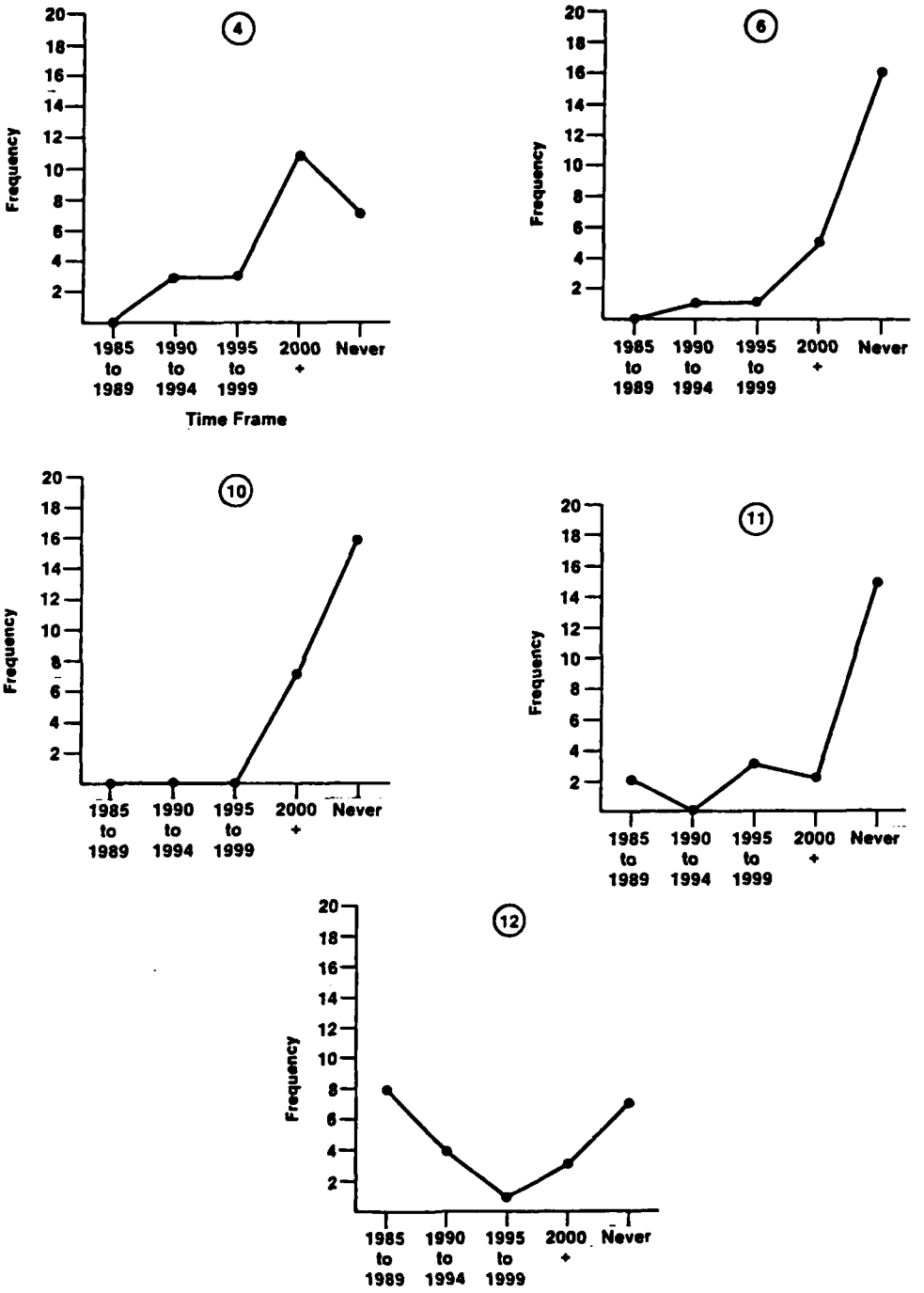

Figure 3 — Evaluations of Combat Ration Development Scenarios

Ration Preservation Methods

After evaluating the 15 scenarios, 5 questions were posed to respondents on ration preservation, biotechnology, new combat rations, new commercial food products, and topics for subsequent surveys.

Five scenarios in the first part of the survey addressed the topic of ration preservation. To validate these results, respondents were asked in Question 16 to name the dominant preservation method for future combat rations. The response given most often was that there would be no dominant method for preserving future ratios. Considering that thermal processing has been the dominant ration preservation method for over 100 years, this response was surprising. Perhaps most respondents believe that less utilized methods will become more widely used as technological advances overcome the drawbacks of current alternative preservation methods, or that no one method will be used exclusively in the future. Despite its current high cost, the preservation method of freeze dehydration or dehydration was the second most frequent response. Other technologies mentioned more than once were low water activity, aseptic packaging, and irradiation. These results indicate that future ration systems will rely on many technologies to provide optimal products to the soldier. Responses are summarized in Table 4.

TABLE 4. Predicted Dominant Ration Preservation Methods.

Response	Frequency	Percent of Respondents*
No Dominant Method	6	28.6
Dehydration/Freeze Dehydration	5	23.8
Low Water Activity	3	14.3
Aseptic Packaging	2	9.5
Irradiation	2	9.5
Infusion/Compression	1	4.8
Food Additives	1	4.8
Don't Know	1	4.8

*Not all of the 23 respondents supplied answers, and percentages have been rounded off.

Although several scenarios from the first part of this survey indirectly addressed possible contributions of biotechnology, none specifically referenced this emerging field. In Question 17, respondents were asked to name the most significant contribution of biotechnology to military ration development. Having named several possible contributions of biotechnology in other scenarios, responses that mirrored these ideas were expected. The most frequently listed were genetic engineering, nutrient fortification, and redefined nutritional requirements. None of these contributions were mentioned elsewhere in the survey. Other responses mentioned more than once were minimal impact and no

comment/no opinion (Table 5). Although biotechnology has the potential to influence military rations in many areas, specific contributions are not known at this time.

TABLE 5. Predicted Contributions of Biotechnology to Ration Development.

Response	Frequency	Percent of Respondents*
Genetic Engineering	5	23.8
Nutrient Fortification	3	14.3
Redefined Nutritional Requirements	3	14.3
Minimal Impact	3	14.3
No Comment/No Opinion	2	9.5
Food Heating	1	4.8
Biochemical/Biogenic Aids	1	4.8
Shelf Stability	1	4.8
Unconventional Food Sources	1	4.8
Synthetic Ingredients	1	4.8
Food Preservation	1	4.8

*Not all of the 23 respondents supplied answers, and percentages have been rounded off.

While the entire survey addressed issues relating to combat rations, none of the scenarios required respondents to evaluate specific ration characteristics. In Question 18, respondents were asked to list three essential characteristics of a successful new combat ration. Since minimal weight and cube has been the primary goal of combat ration research and development for years, this response was expected to be named most often. Other characteristics expected to be named frequently included acceptability, long shelf life, and producibility. The most frequent response was acceptance/consumption, with low weight/volume mentioned next most often. High stability was the next most frequent response, followed by fully prepared/no preparation. Responses are summarized in Table 6.

Question 19 moved slightly away from the subject of ration development and asked respondents to list three essential characteristics of a successful new commerical food product. The reasoning behind this question was to determine if any characteristics that make a combat ration successful also determine the success of commerical products. According to survey results, the characteristics most critical to the success of a new commerical food product are convenience, acceptability, and cost.

In comparing the top three responses to Questions 18 and 19, only acceptability was common, selected most often for combat rations and second most often for new commerial food products. Given these results, it would be reasonable to conclude that acceptability should be among the top priorities when developing new commerical food products or combat rations.

TABLE 6. Essential Characteristics of a Successful New Combat Ration.

Response	Frequency	Percent of Respondents*
Acceptance/Consumption	15	65.2
Light Weight/Low Volume	10	43.5
High Stability	9	39.1
Fully Prepared	7	30.4
Nutritionally Complete	5	21.7
Performance Enhancement	4	17.4
Calorically Dense	3	13.0
Affordable/Producible	3	13.0
High Quality/Recognizable	2	8.7
Nutrient Dense	1	4.3
Easily Decontaminated	1	4.3
Logistically Supportable	1	4.3
Low/No Water Requirement	1	4.3
Variety	1	4.3

*Not all of the 23 respondents supplied answers, and percentages have been rounded off.

Convenience, while important for the success of combat rations, is essential for new commercial food products. Increasing use of microwave ovens has spurred tremendous growth in commercial retail food products to the point where a lack of microwavability must be considered a serious flaw in a prepared food product.

Likewise, while cost is important to combat rations, it is one of the deciding factors to survey participants as consumers when purchasing new foods. For combat rations, cost is important because of the large quantities purchased for reserve stocks. With increasing scrutiny of defense expenditures, higher prices without improved quality may not be approved. Responses are summarized in Table 7.

The first survey closed with an open-ended question that asked respondents to list any areas they would like to see addressed in subsequent surveys. Only 10 respondents elected to answer this question, a disappointing percentage.

A commonality among the responses received concerned the acceptability of rations. Specifically, these respondents wanted to know whether more highly engineered rations would be accepted, how acceptability varies with the dining environment, and the effect of marketing a ration on acceptability. Other suggestions included the addition of questions on chemical or microbiological stability, food and water packaging, types of food in rations, and individual versus group feeding. In developing the second survey, many of these suggestions were used along with selected responses from other portions of the first survey to focus more closely on the characteristics of combat rations for the future and the concepts for their use.

TABLE 7. Essential Characteristics of a Successful New Commercial Food Product.

Response	Frequency	Percent of Respondents*
Convenience	14	60.9
Acceptability	13	56.5
Cost	10	43.5
Nutritionally Complete	5	21.8
Shelf Stable	3	13.0
High Quality	2	8.7
Fills Need	2	8.7
Natural Taste/Texture	1	4.3
Microwaveable	1	4.3
Variety	1	4.3
Appearance	1	4.3
Marketing	1	4.3
Packaging	1	4.3
Satisfying	1	4.3
Increased Sales	1	4.3
Varied Portions	1	4.3
Trendy	1	4.3
Tasty	1	4.3

*Not all of the 23 respondents supplied answers, and percentages have been rounded off.

TRENDS IN COMBAT RATION DEVELOPMENT PART II: RESULTS AND DISCUSSION

The objective in designing the second survey in this Delphic poll, "Trends in Combat Ration Development Part II," was to focus on specific combat rations of today and to speculate on ration concepts for tomorrow. Whenever possible, these questions incorporated results of the first survey in an attempt to develop a consensus on issues affecting combat ration development. This second survey consisted of 10 questions, with 4 requiring open-ended responses and 6 requiring multiple choice, closed-ended responses. The response rate for this second survey was approximately 83%, as 19 out of a possible 23 surveys were returned. All potential respondents were sent personalized reminder memorandums the day after responses were due, but no additional surveys were received despite this effort.

A consensus of opinion was apparent on two major issues when survey results were tabulated. First, respondents indicated that the MRE and tray pack will remain viable until the end of this century, and second, there is agreement on the most desirable characteristics for new rations. A copy of the survey is included in this report as Appendix B.

Goals of Combat Ration Research and Development

The first survey made inquiries about the characteristics necessary for successful new commercial and military food products. Utilizing the responses to these inquiries, the first question asked respondents to select three goals of combat ration research and development that would facilitate the achievement of these essential characteristics during the 1985 to 2000 time period. Three responses were chosen by a majority of respondents with little discrimination. The three responses were reducing weight and cube, NBC consumption, and factors of consumption. Two other responses mentioned frequently were performance enhancement and producibility. Results are summarized in Table 8.

TABLE 8. Goals of Ration Research and Development.

Response	Frequency	Percent of Respondents*
Reducing Weight/Cube	12	66.7
NBC Consumption	11	61.1
Factors of Consumption	10	55.5
Performance Enhancement	8	44.4
Producibility	6	33.3
Low Cost	3	16.7
Special Nutritional Needs	3	16.7
Simple Decontamination	3	16.7
Extended Shelf Life	2	11.1

*Not all of the 23 respondents supplied answers, and percentages have been rounded off.

Use of Artificial Substances

In the first survey, most respondents indicated that future military rations may contain behavior modifying substances to improve battlefield performance. The second survey asked respondents for three physiological or psychological factors that possibly should be controlled through the addition of artificial substances. Responses to the question indicated that substances should be used primarily to increase mental alertness above all else. Other responses cited frequently were increase endurance, control stress, and improve digestion.

Since the addition of drugs to food or rations is prohibited by the Office of the Surgeon General (OTSG), the question of whether substances should be added to rations to modify behavior becomes moot. Since various drugs are available to modify behavior as suggested in this question, future ration developers and OTSG will face an important moral dilemma in deciding what role, if any, behavior modifying substances should play.

This question was recently addressed in developing the Army 21 Statement of Need for the nutritional sustainment module. All of the behavior modifications listed in this question could be considered as advantageous on the future battlefield. In effect, this question asked respondents to choose the most desirable changes, and the responses probably represent subjective evaluations rather than objective judgements.

As such, the results to this question serve as a useful point to begin discussing the topic of adding behavior modifying substances to rations. Complete results for Question 2 are summarized in Table 9.

TABLE 9. Behavior Modification Through Artificial Substances.

Response	Frequency	Percent of Respondents*
Mental Alertness	12	66.7
Increased Endurance	11	61.1
Stress Control	9	50.0
Digestive Aids	9	50.0
Improved Sleep	5	27.7
Fear Reduction	2	11.1
Psychological Conditioning	2	11.1

*Not all of the 23 respondents supplied answers, and percentages have been rounded off.

Highly Engineered Rations

The first survey addressed the issue of highly engineered, unrecognizable rations, and most respondents agreed that all combat rations will be highly engineered after 1990. Question 3 asked respondents how long highly engineered

rations would be readily consumed in a future combat situation. A majority of respondents indicated that highly engineered food items would be readily consumed for a period of 10 days. The next most frequent response was 15 days. The least frequent responses were 5 days and 30 days. These results indicate that respondents believe the human palate will tolerate "highly engineered foods" for 10 to 15 days in the future. Some responses were qualified by statements like "will depend on motivation of troops". Results are summarized in Table 10.

TABLE 10. Consumption of Highly Engineered Rations.

Response	Frequency	Percent of Respondents*
5 days	3	16.7
10 days	8	44.4
15 days	5	27.7
30 days	3	16.7

*Not all of the 23 respondents supplied answers, and percentages have been rounded off.

Irradiation for Commercial Sterilization

Results from the first survey indicated that irradiation will become widely used to produce shelf stable foods after 1990. To confirm these results, Question 4 inquired when irradiation will be used for commerical sterilization of combat rations. Respondents could select one of three time frames: 1990-1994, 1995-1999, and 2000+. Since there has been increased commercial and regulatory interest in irradiation recently, this technology is receiving more press coverage than ever before. The majority of those responding indicated that irradiation will be used for commercial sterilization during the 1995-1999 time period, while a considerable number of respondents selected the time frames of 1990-1994 and 2000+. These results indicate that while irradiation technology may be available, other factors such as FDA regulations, consumer education, and acceptability may limit its use. Complete results are summarized in Table 11.

TABLE 11. Irradiation for Commercial Sterilization.

Response	Frequency	Percent of Respondents*
1990-1994	5	27.7
1995-1999	8	44.4
2000 +	5	27.7

*Not all of the 23 respondents supplied answers, and percentages have been rounded off.

The Meal, Ready-to-Eat

In the first survey, many respondents indicated that the Meal, Ready-to-Eat (MRE) will remain viable into the 21st Century. In Question 5 respondents were asked to select a characteristic of the MRE which would be the key to its longevity. Since the raison d'etre for the MRE is the retort pouch, this response was expected to be the most frequent. Other characteristics expected to be named often were MRE variety and its convenience. Somewhat surprisingly, the most frequent response was acceptability, which refers to the appearance, taste, and texture of the ration. The second most frequently mentioned characteristic was recognition, with pouch technology being the next most mentioned. Results are summarized in Table 12.

TABLE 12. MRE Characteristics: Key to Longevity of Use.

Response	Frequency	Percent of Respondents*
Acceptability	6	33.3
Recognition	4	22.2
Retort Pouch	3	16.7
Food Quality	2	11.1
Convenience	2	11.1
Low Volume	1	5.5

*Not all of the 23 respondents supplied answers, and percentages have been rounded off.

The Tray Pack

Results from the first survey also indicated that the tray pack will remain viable into the 21st Century. In Question 6 respondents were asked to name a characteristic of the tray pack that they believe would be the key to its longevity. The tray pack has two predominant characteristics. First, the half steam table tray container can be easily heated by several methods and be ready for serving in only 30 minutes. Second, the food in a tray pack is of higher quality due to the shorter processing times allowable by the shallow tray container. The most frequent response was convenience, mentioned by more than half of all respondents. Only two other characteristics, availability and acceptability, were mentioned more than once. Five other responses were each mentioned once. Complete results are summarized in Table 13.

Optimal Caloric Density and Acceptability/Consumption

Nearly 68% of those responding to the first survey indicated that reducing weight and cube will be the focus of military ration research and development in the foreseeable future. To confirm these results, respondents were asked when the trade-off between acceptability/consumption and optimal caloric density

TABLE 13. Tray Pack Characteristics: Key to Longevity of Use.*

Response	Frequency	Percent of Respondents*
Convenience	10	55.5
Availability	2	11.1
Acceptability	2	11.1
Food Quality	1	5.5
Container	1	5.5
Recognition	1	5.5
Obsolete	1	5.5
Non-Contaminable	1	5.5

*Not all of the 23 respondents supplied answers, and percentages have been rounded off.

for combat rations will be achieved. The following time frames were available for selection: 1985-1989; 1990-1994; 1995-1999; and 2000+. More than half of those responding selected the 1990-1994 time frame, indicating that reducing weight and cube will be the focus of ration research and development for the next 5 to 10 years. A considerable number of respondents indicated that this development might not occur until the 1995-1999 period, or perhaps until the 2000+ time frame. From these results, one can reasonably conclude that, at least for the near future, researchers will be seeking to optimize combat ration weight, cube, and acceptablity. Results from Question 7 are summarized in Figure 4.

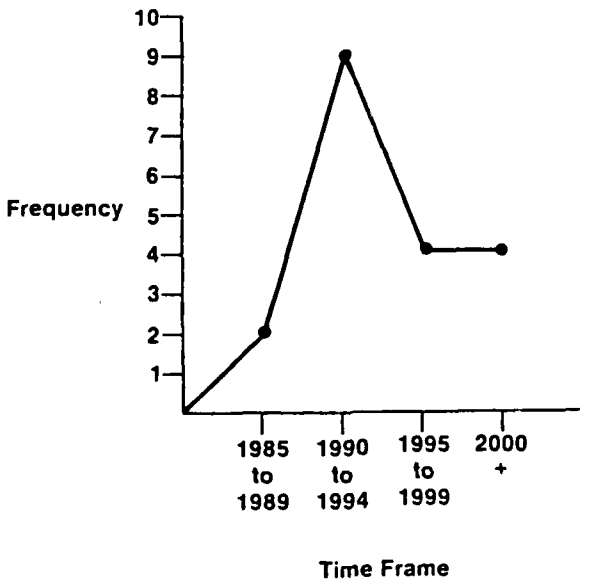

Figure 4 — Response Summary — Question 7

Rations as Fuel for the Battle

When the results from the first survey were tabulated, respondents were equally divided on whether or not future highly motivated soldiers would ever view rations as "fuel for the battle", thus negating the need for highly acceptable foods. To clarify these results, Question 8 in the second survey asked respondents what the probability of success would be for a program designed to convince future combat soldiers to view rations as "fuel for the battle" by the year 2000. Most respondents gave either numerical percentages or short phrases. For analysis purposes, all responses were separated into four categories of probability: low, medium, high, and other. Any percentages less than or equal to 33% were placed in the low category; percentages from 34% to 66% were placed in the medium category, and percentages greater than or equal to 67% were placed in the high category. All remaining responses were placed in the other category. The overwhelming majority of responses fell into the low probability category. This response confirms the results of the first survey that motivation to consume unfamiliar foods has many deeply learned barriers which will not be overcome easily. All responses are summarized in Figure 5.

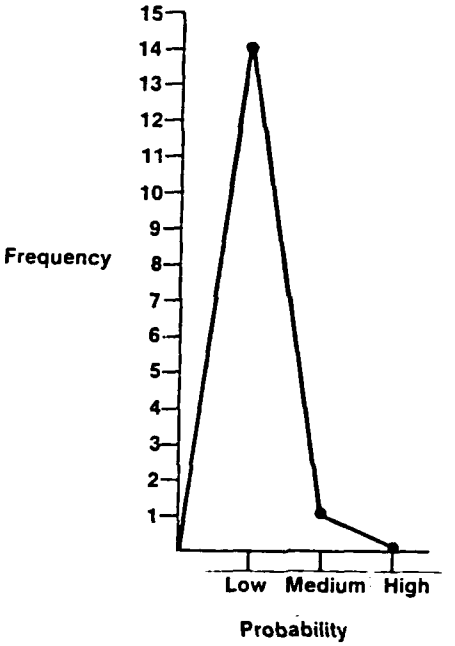

Figure 5 — Response Summary — Question 8

Future Combat Ration Preservation

In the first survey, respondents were asked which preservation/processing technique would dominate future combat ration production. The responses were evenly distributed across several categories, including dehydration, freeze dehydration, low water activity, irradiation, and no dominant method. This was interpreted as indicating that the ration system of the future would rely on several techniques and not be dominated by one. To clarify these results, the second survey asked respondents to select four preservation methods that

will be the most widely used for future combat rations. The results were similar, as responses were evenly distributed across the following categories listed in descending order of importance: thermal pouches, freeze dehydration and low water activity (tie), aseptic packaging, and other dehydration.

Four of the five methods with the highest ratings from the first survey also received the highest ratings in the second survey. The most notable exception from the results of the second survey was the absence of the "no dominant method" response, which was not available for selection unless the "other" category was selected. Other notable differences included the top rank assigned to thermal pouches and the high rank assigned to aseptic packaging. From these results, one can reasonably conclude that food preservation by means of thermal pouches, freeze dehydration, and low water activity will be widely used for future combat rations. Other methods that could become widely used are aseptic packaging and freeze dehydration. Results are summarized in Table 14.

TABLE 14. Future Combat Ration Preservation Techniques.

Response	Frequency	Percent of Respondents*
Thermal Pouches	12	66.7
Freeze Dehydration	10	55.5
Low Water Activity	10	55.5
Aseptic Packaging	9	50.0
Other Dehydration	8	44.4
New/Novel Methods	5	27.7
Additives	3	16.6
Infusion	1	5.5
Thermal Plastic	1	5.5

*Not all of the 23 respondents supplied answers, and percentages have been rounded off.

Water Concerns

The final question addressed the topic of water. Specifically, respondents were asked to identify major issues concerning water on the future battlefield that could be addressed in new ration concepts. The majority of respondents identified water supply as the major issue. Respondents cited several factors relating to water supply, including the amount of water required, whether water will be distributed to groups or individuals, when water will be supplied, and how water will be supplied. A second issue was water purification, especially in light of the increased NBC contamination threat. A third issue identified was the amount of water required to reconstitute dehydrated rations and the effect on thirst, if any, caused by the consumption of dehydrated rations.

Other water-related issues identified included consumption in an NBC environment, improved taste through the use of nonreactive disinfectants, and whether water requirements can be reduced through adjustments to the levels of protein and salt in new rations. Overall, the responses to this question indicated that the most important water-related issue on the battlefield is the ability to supply enough clean, potable water to everyone whenever, and wherever, it is needed. Responses for this question are summarized in Table 15.

TABLE 15. Water Concerns.

Response	Frequency	Percent of Respondents*
Availability/Supply	8	42.1
Purification	5	26.3
Rehydrate Rations	3	15.8
NBC Consumption/Contamination	2	10.5
Thirst	1	5.3

*Not all of the 23 respondents supplied answers, and percentages have been rounded off.

TRENDS IN COMBAT RATION DEVELOPMENT PART III: RESULTS AND DISCUSSION

Trends in Combat Ration Development Part III, the last of the three surveys comprising the Delphic poll, was distributed approximately 7 weeks after the first survey. This survey was, perhaps, the most important of the three. The first survey asked very broad questions and the results were general in nature. The second survey incorporated many of these results into questions that more clearly focused on several issues of ration development. The objective in this the third and final survey was to reach a consensus among respondents that would allow project personnel to make several definitive statements about the goals of future combat ration development.

Previous analysis of Army 21 requirements indicated that four types of food service are required for Army 21: a category I ration intended for limited use in intense conflicts; a category II operational ration similar to today's MRE for short-term use; a category III ration for longer-term and vehicle use; and a category IV group ration similar in capacity and concept to today's Tray Pack.

Respondents were required to select 5 characteristics from a list of 11 characteristics that they thought were most important for each of the 4 ration categories. The 11 characteristics were derived from the responses to similar questions in Surveys I and II. The survey closed by asking respondents how research and development effort should be allocated into the following areas: improving existing rations, new ration development, and basic food research. Once again, these areas were derived from the responses to questions in earlier surveys. A copy of the survey is included in this report as Appendix C.

Category I

Under the heading category I, respondents were asked to select the five most important characteristics of a ration system for individual troops in intense combat without resupply for periods up to 5 days. In describing this ration a survival type ration was envisioned. Respondents were asked to select the 5 most important characteristics from a list of 11 presented in the question. The characteristic selected by respondents as most important was ease of use, which was the only unanimous selection in this category. The second most important characteristic was low weight/cube, which was selected by 95% of those responding. The characteristic of acceptability was selected as third most important, being mentioned by 80% of those responding. The characteristics of performance enhancement and easily decontaminated were the fourth most popular responses, being selected by 65% of those responding. None of the remaining characteristics were selected by more than 25% of those responding. Complete results are summarized in Figure 6.

Category II

For category II, respondents were asked to select the five most important characteristics of a ration system for individual troops in moderate levels of combat for up to 4 weeks, with 3 to 5 days resupply. The characteristics of low weight/cube and acceptability were both selected by 95% of the sample. The characteristic selected as third most important was ease of use, with a response of 65%. The characteristics of easily decontaminated, and repeated consumption

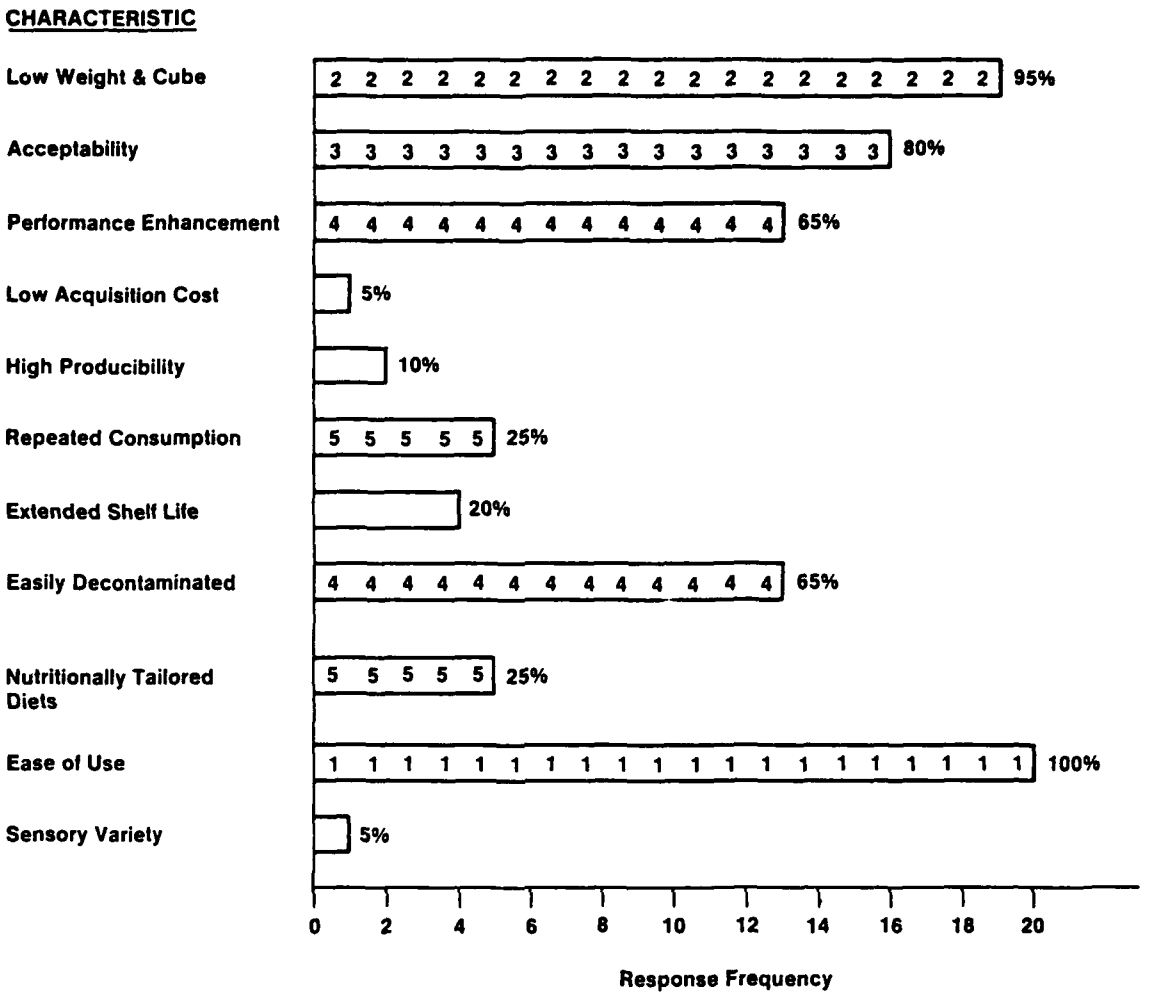

Figure 6 — Ration Category I Responses

were each selected by 50% of those responding. All of the remaining characteristics were selected by less than 50% of those responding. Complete results are summarized in Figure 7.

Category III

For category III, respondents were asked to select the five most important characteristics of a ration system for individual or group use by troops in low levels of combat for extended periods with established resupply. Acceptability was selected by 95% of those responding, making this characteristic the most important. The second most important characteristic was sensory variety, which was selected by 70% of the sample. The characteristic of nutritionally tailored diets was selected by 65% of those responding, making it third most important. Repeated consumption was the fourth most important characteristic and garnered a response of 60%. All of the remaining characteristics were selected by less than 50% of the sample, including extended shelf life, the fifth most important, with a response of only 45%. Complete results are summarized in Figure 8.

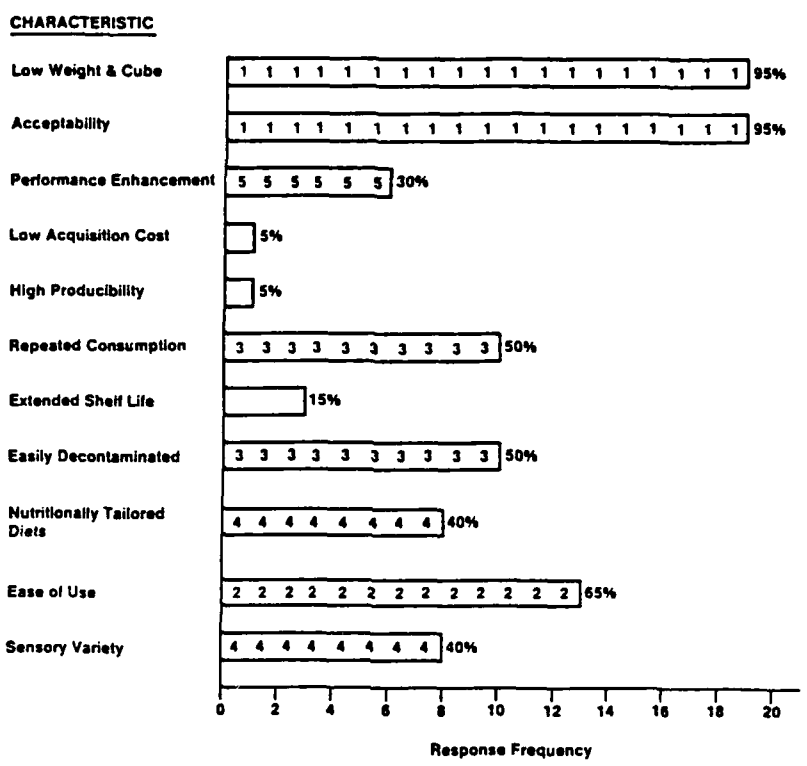

Figure 7 — Ration Category II Responses

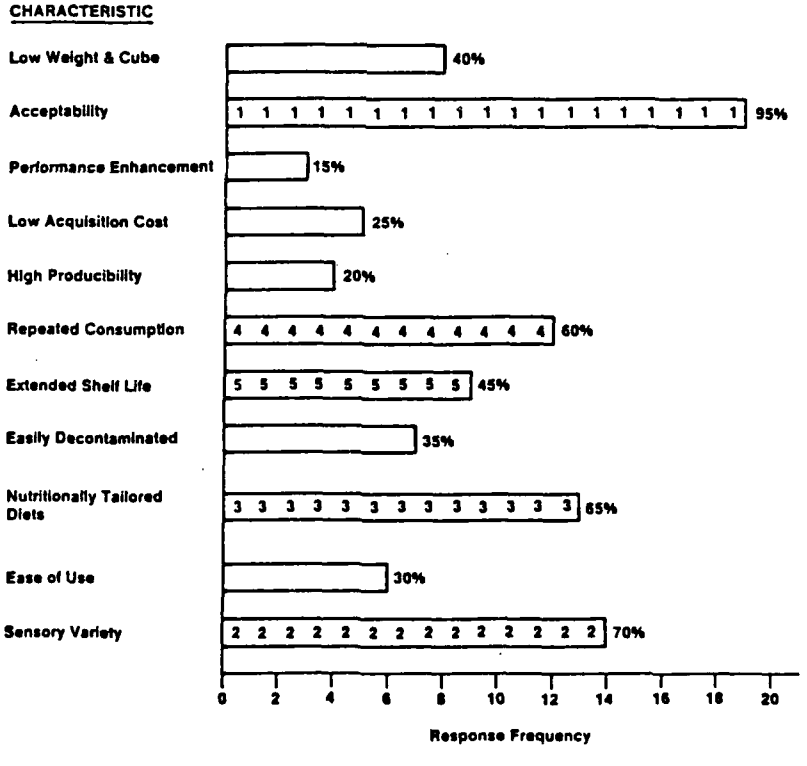

Figure 8 — Ration Category III Responses

Category IV

For category IV, respondents were asked to select the five most important characteristics of a ration system for groups featuring a hot meal in stable environments for extended periods. Respondents selected acceptability as the most important characteristic for this category with a response rate of 95%. The second most important characteristic was sensory variety, which was selected by 80% of those responding. The characteristics of high producibility and nutritionally tailored diets were both selected by 70% of the sample, making them the third most important. Repeated consumption was selected by 50% of those responding, making this characteristic the fourth most important. All of the remaining characteristics were selected by less than 50% of the sample, including low acquisition cost and extended shelf life, which were selected by 45% of those responding, making these characteristics the fifth most important. Complete results are summarized in Figure 9.

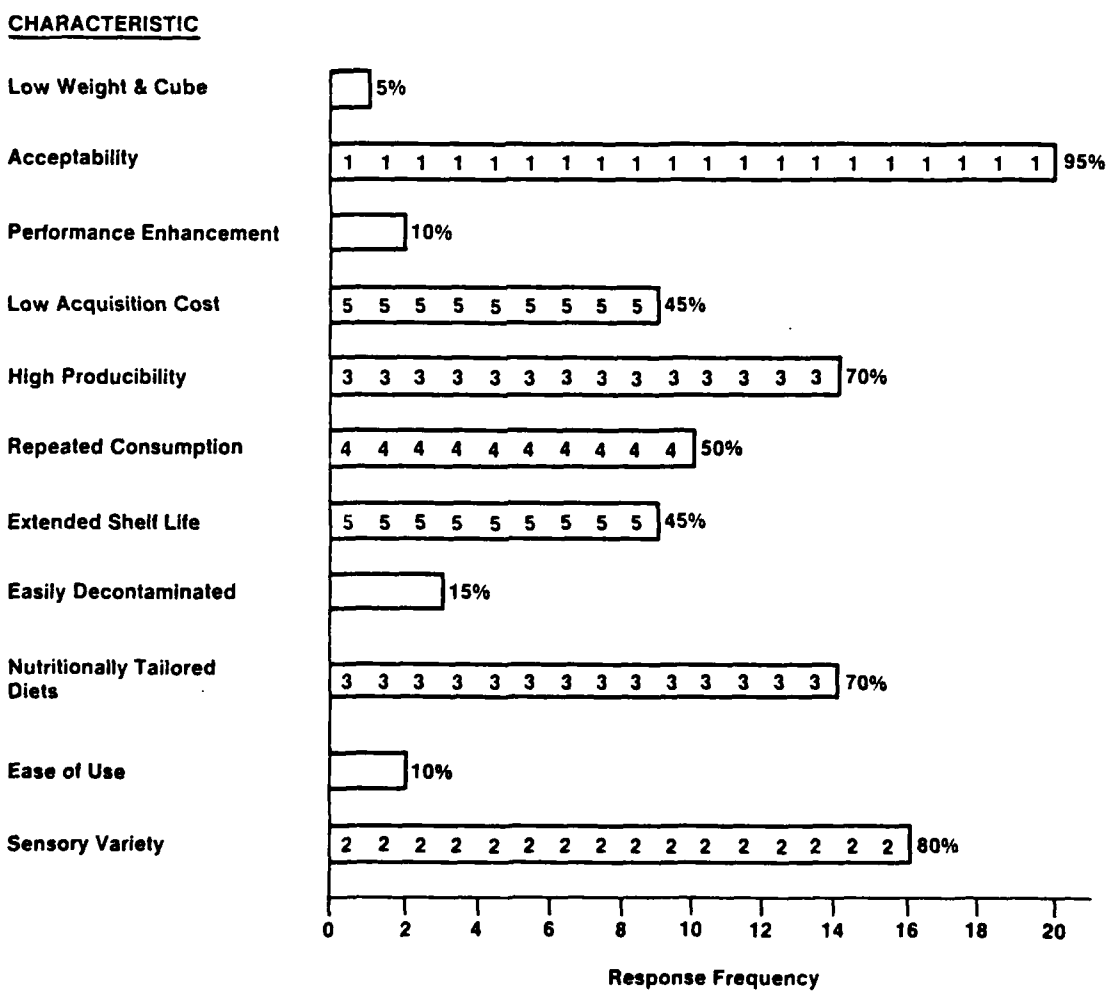

Figure 9 — Ration Category IV Responses

Food Service Summary

Now that each ration category has been evaluated individually, all four categories must be discussed as one food service system. Respondents were asked to list the most important characteristics of a ration for individual troops in intense combat without resupply for up to 5 days in food service category I. The five characteristics selected as most important in descending order of importance were ease of use, low weight and cube, acceptability, performance enhancement, and easily decontaminated. In category II, respondents were asked to list the most important characteristics of a ration for individuals in moderate levels of combat for up to 4 weeks with a 3 to 5 day supply. The characteristics selected as most important in descending order of importance were low weight and cube, acceptability, ease of use, repeated consumption, and easily decontaminated.

In comparing the responses to these first two categories, four of the five characteristics selected were the same for both categories. This indicates that our respondents think that the two rations should have some similar characteristics. Ideally, the first two rations will have many similar components with the rations in category II being supplemented category I rations. The characteristics selected for both categories were ease of use, low weight and cube, acceptability, and easily decontaminated. The characteristic for category I, not in common with category II, was performance enhancement, while repeated consumption for category II was not in common with category I. These two characteristics coincide with the intended uses of these proposed rations as described in the survey. The first category described a ration designed to provide nutritional sustainment for a limited period; thus, this ration should enhance performance. The second category described a ration designed to be eaten for extended periods; thus, repeated consumption becomes important. These results indicate that while all rations should share some basic characteristics, future rations must also be flexible enough to become mission specific when required.

For ration category III, respondents were asked to select the five most important characteristics of a ration system for individuals or groups in low levels of combat for extended periods with established resupply. The characteristics selected in descending order of importance were acceptability, sensory variety, nutritionally tailored diets, repeated consumption, and extended shelf life. In ration category IV, respondents were asked to select the five most important characteristics of a ration system which provides a hot meal to groups in stable environments for extended periods. The following characteristics were selected in descending order of importance: acceptability, sensory variety, high producibility, nutritionally tailored diets, and repeated consumption.

Like the comparison of categories I and II, a comparison of categories III and IV revealed four similar characteristics. Hot meals were envisioned for both categories III and IV, with the former being an individual ration and the latter being a small group ration. The survey descriptions of these two ration concepts did not, however, infer any similarities between the two categories. The four similar characteristics were acceptability, sensory variety, nutritionally tailored diets, and repeated consumption. The characteristic selected for category III not in common with category IV was extended shelf life, while high producibility was the characteristic for category IV not in common with category III. In combat situations operational rations are used most often; therefore, more operational rations must be kept in reserve. Respondents apparently

inferred that the category III ration will be an operational ration, and consequently selected the characteristic of extended shelf life as one of the five most important. Not surprisingly, acceptability was the only characteristic selected as most important for all four categories.

Having discussed the overall results for the four categories of rations there is still no clear-cut answer as to which other characteristics are most important for all rations. By examining survey results more closely, perhaps several characteristics of importance to all ration types will become evident. In this section, each characteristic will be defined. Then, survey results will be discussed. Finally, those characteristics of universal importance to all ration categories will be identified.

Low Weight and Cube

The characteristic low weight and cube refers to the physical dimensions and volume of rations. Overall, this characteristic was selected as among the most important 47 times, the second highest cumulative total. Respondents selected low weight and cube as the most important characteristic for category II rations and second most important for category I rations. Selections in ration categories I and II accounted for over 80% of the cumulative total for the low weight and cube characteristic. These responses indicate that low weight and cube is of the utmost importance for individual rations intended for use in active combat. Low weight and cube becomes less important for troops in low levels of combat using individual rations and relatively unimportant for group rations used in stable environments. Responses are summarized in Figure 10.

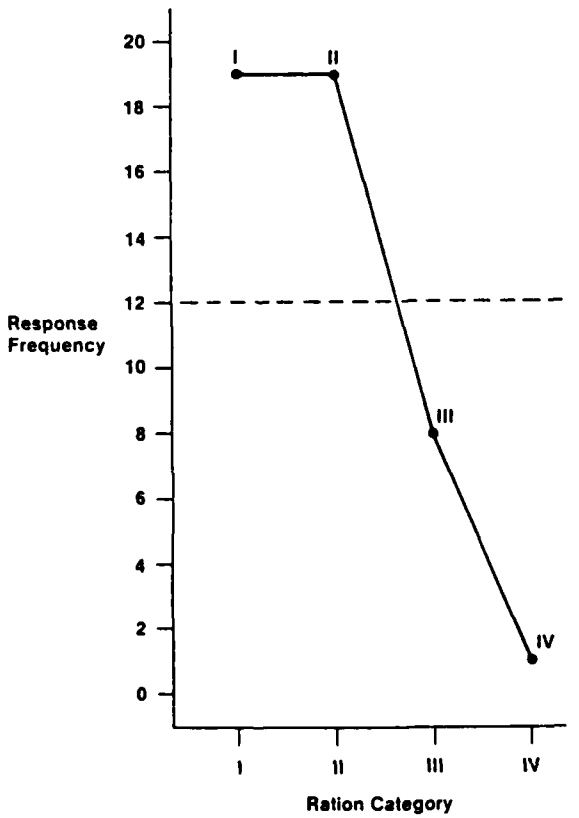

Figure 10 — Low Weight and Cube Response

Acceptability

Not surprisingly, the characteristic acceptability was selected as among the most important 74 times, the highest cumulative total. Respondents selected acceptability as the most important characteristic for rations in categories II, III, and IV. In ration category I, acceptability was selected as third most important. These results were not surprising because troop acceptance must be high enough to ensure that the ration is eaten. Judging from survey responses, acceptability of rations should continue to be a high priority, if not the highest priority, in developing new rations. Responses are summarized in Figure 11.

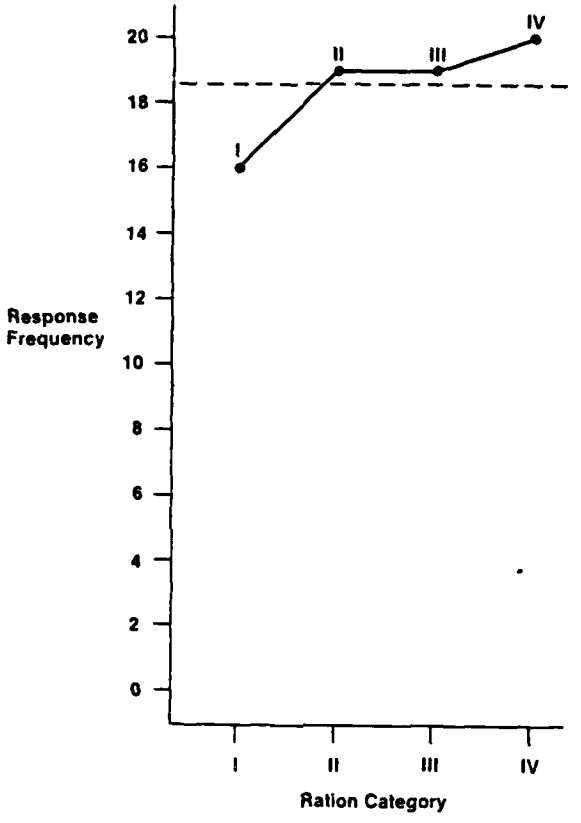

Figure 11 — Acceptability Response

Performance Enhancement

The characteristic performance enhancement refers to the supplementation of rations for the purpose of improving soldier performance. Overall, only 30% of those responding selected this characteristic as among the most important. On an individual basis, respondents ranked performance enhancement as fifth most important in categories I and II, its highest rankings. These results indicate that while performance enhancement may be a desirable ration characteristic, it is not universally important. Responses are summarized in Figure 12.

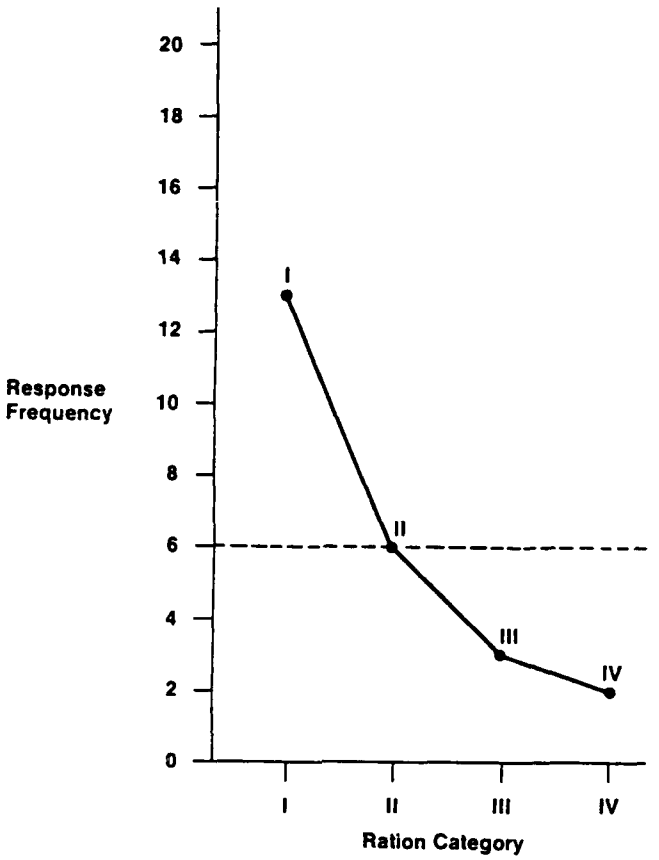

Figure 12 — Performance Enhancement Response

Low Acquisition Cost

Of all 11 characteristics evaluated, low acquisition cost was selected as the least important by respondents. Overall, only 20% of those responding selected this characteristic as among the most important. The characteristic of low acquisition cost was selected as fourth most important in category IV, its highest ranking. Judging from these results, respondents apparently believe that acquisition costs are of little importance in individual special purpose rations. Results are summarized in Figure 13.

High Producibility

The characteristic high producibility refers to the efficiency of the ration production process. Overall, slightly over 26% of those responding selected this characteristic as among the most important for the four ration categories.

The characteristic of high producibility was selected as the third most important in category IV, its highest ranking. Rankings in all other categories were not among the five selected as most important. These results indicate that

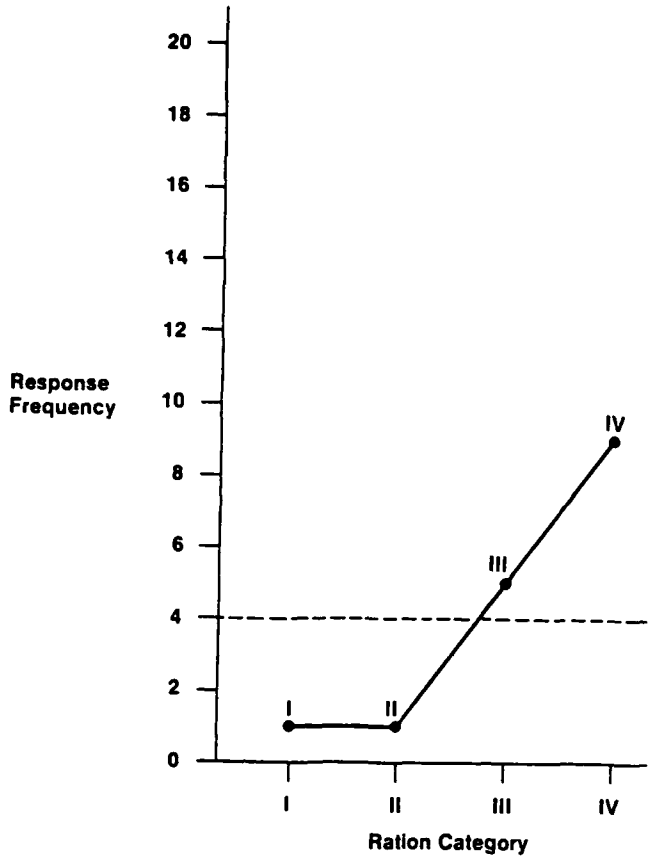

Figure 13 — Low Acquisition Cost Response

high producibility is more important in high volume group rations and less important in lower volume specialized individual rations. On a cumulative basis, high producibility was the second least selected characteristic. Results are summarized in Figure 14.

Repeated Consumption

The characteristic of repeated consumption refers to the actual consumption of a ration for the prolonged periods of time. This characteristic differs from acceptability in that a ration may prove to be acceptable in taste tests, but it will not be continually consumed whenever it is offered. Overall, slightly over 46% of those responding selected this characteristic as among the most important for the four categories. Repeated consumption was selected as the third most important characteristic in category II, its highest ranking, although it was selected more often in category III. This characteristic was selected by at least 50% of those responding in all categories except I, where only 25% selected repeated consumption as important. On a cumulative basis, repeated consumption was ranked sixth out of 11 characteristics. Judging from these results, respondents apparently believe that repeated consumption is an important ration characteristic, but that it is not among the five most important. Results are summarized in Figure 15.

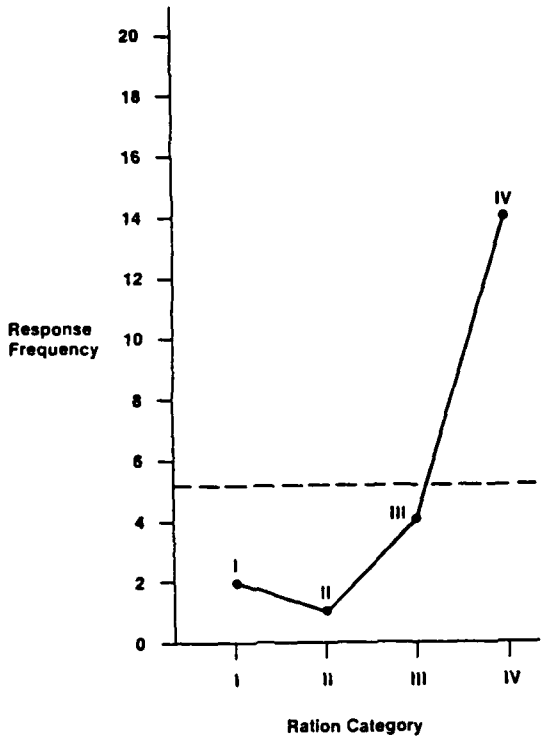

Figure 14 — High Producibility Response

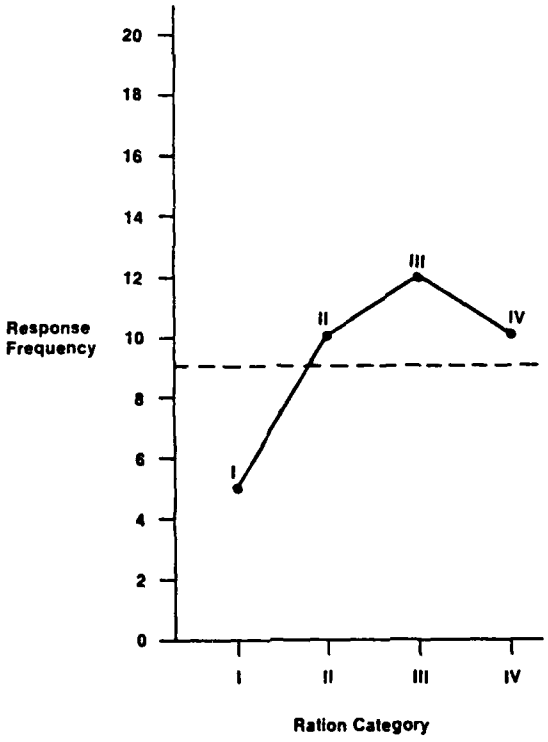

Figure 15 — Repeated Consumption Response

Extended Shelf Life

The characteristic extended shelf life refers to a longer useful life for rations. Currently, the minimum acceptable shelf life for a ration is 3 years; thus, anything beyond 3 years may be considered as extended shelf life. Overall, slightly over 31% of those responding selected extended shelf life as among the most important characteristics. Respondents selected extended shelf life as the fifth most important characteristic in both categories III and IV, its highest ranking. Rankings in the remaining categories were not among the top five. These results indicate that extended shelf life, while among the most important characteristics for some rations, is of low to medium priority overall. On a cumulative basis, extended shelf life was ranked as the eighth most important characteristic. Results are summarized in Figure 16.

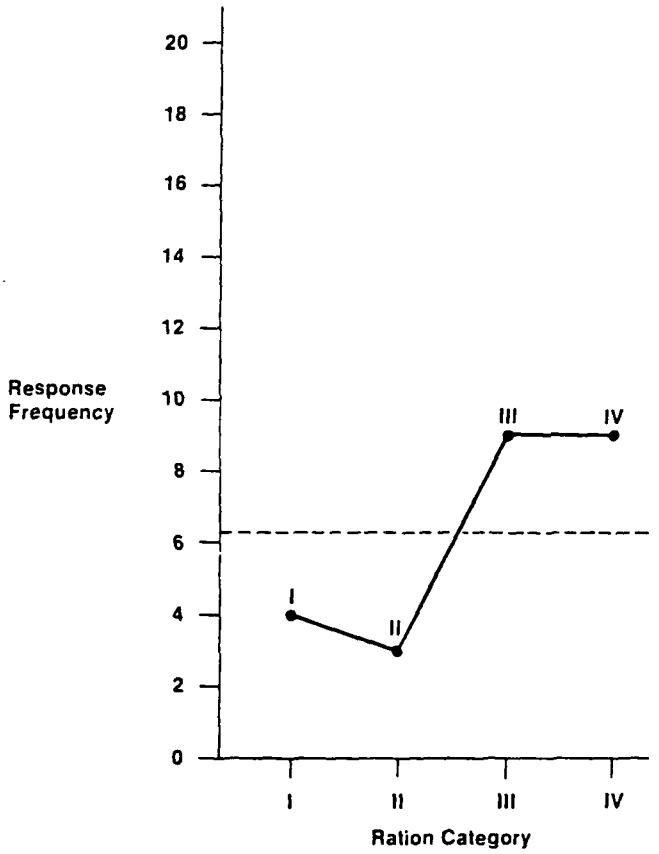

Figure 16 — Extended Shelf Life Response

Easily Decontaminated

With the growing threat of NBC contamination, the ease with which a ration is decontaminated becomes increasingly important. Overall, slightly over 41% of those responding selected this characteristic as among the most important. The

characteristic easily decontaminated was rated highest in categories I and II, where it was ranked fifth and third most important, respectively. Rankings in the remaining two categories were not among the five most important. Judging from these results, respondents apparently believe that easy decontamination is among the most important characteristics for individual operational rations. On a cumulative basis, the characteristic easily decontaminated was ranked as the seventh most important. Results are summarized in Figure 17.

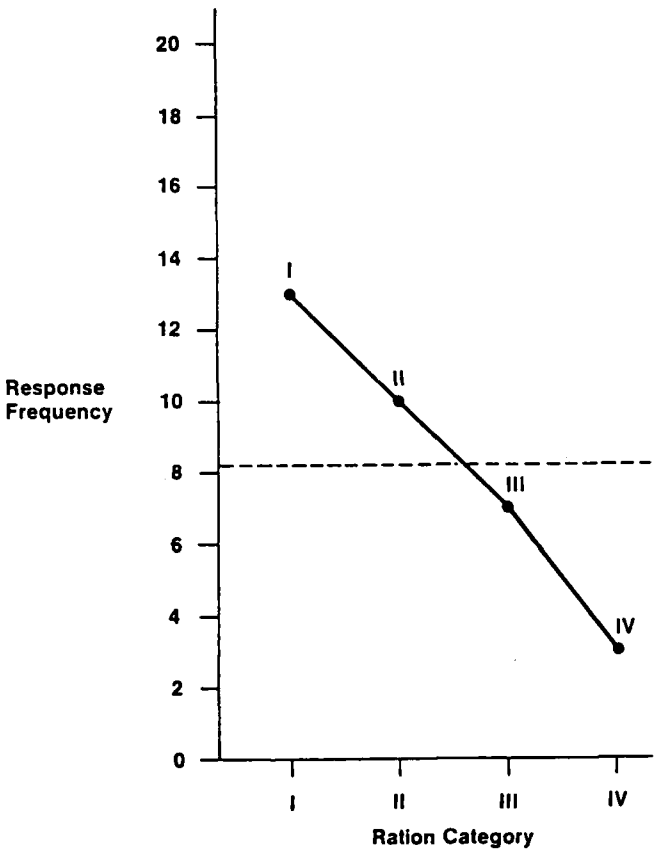

Figure 17 — Easily Decontaminated Response

Nutritionally Tailored Diets

The characteristic nutritionally tailored diets refers to rations that are customized to the physical demands of specific missions. Currently, rations vary by the amount of calories offered to the soldier. In the future, rations will be designed with specific levels of carbohydrates, fats, and proteins which are optimized to and correspond with anticipated levels of activity. Overall, 50% of those responding ranked this characteristic among the most important.

In categories III and IV, respondents selected nutritionally tailored diets as the third most important characteristic, its highest ratings. In addition, respondents ranked nutritionally tailored diets as fourth most important in category II, and fifth most important in category I. On a cumulative basis, the characteristic of nutritionally tailored diets was ranked as the fourth most important. These results indicate that less than optimal nutrition may be tolerated for short periods of time (i.e., category I and II). However, for longer periods of time with less severe restriction (category III and IV) more nutritionally tailored diets are preferred. Results are summarized in Figure 18.

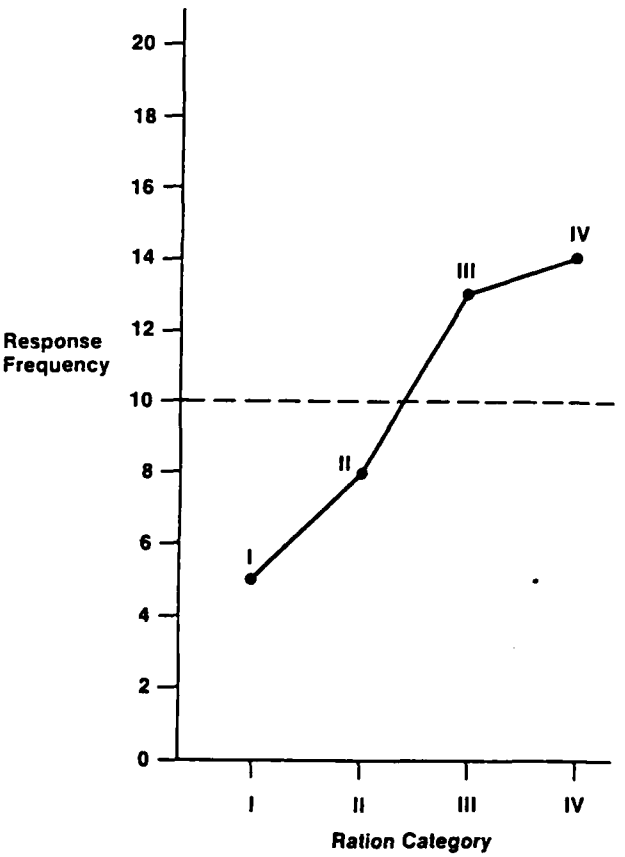

Figure 18 — Nutritionally Tailored Diets Response

Ease of Use

The characteristic ease of use refers to the complexity of the preparation required to make a ration consumable. Current rations require a wide range of preparation, from none to thorough heating, to actual preparation and cooking. Overall, slightly over 51% of those responding selected this characteristic as among the most important. In category I, respondents selected ease of use as the most important characteristic, while in category II this characteristic was selected as the second most important. The ease of use characteristic was not

ranked among the five most important in either category III or IV. On a cumulative basis, respondents ranked ease of use as the third most important characteristic of a ration. Since most selections were in categories I and II, it is reasonable to assume that ease of use is most important for individual operational rations or specific scenarios where little or no time is available for meal preparation. Complete results are summarized in Figure 19.

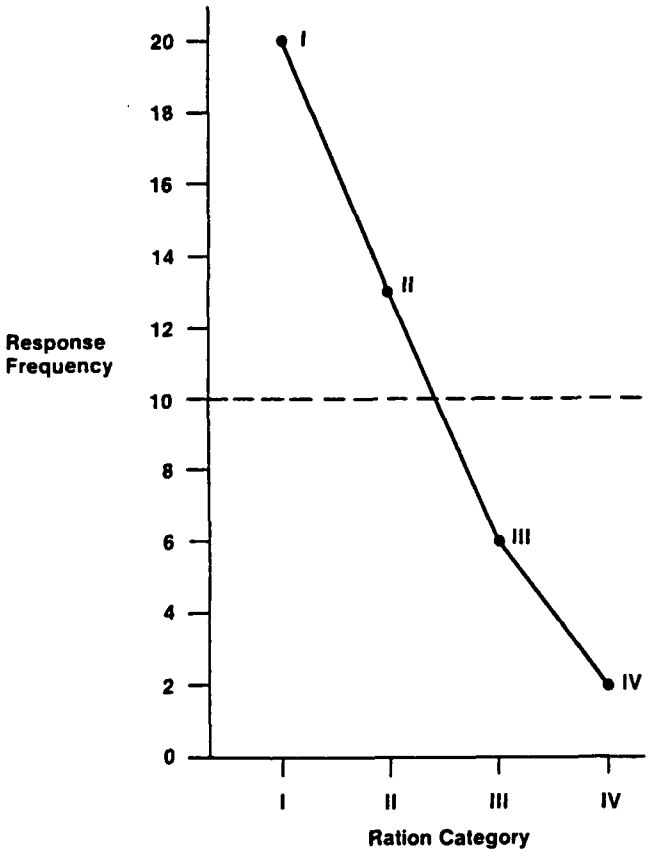

Figure 19 — Ease of Use Response

Sensory Variety

The characteristic sensory variety refers to the overall impression of a ration's appearance, smell, taste, texture, and the degree of satiety after consumption. Overall, approximately 49% of those responding selected this characteristic as among the most important. Sensory variety was selected as the second most important characteristic in categories III and IV, and fourth most important in category II. This characteristic was ranked as the least important in category I, its lowest ranking. On a cumulative basis, respondents ranked sensory variety as the fifth most important characteristic. Complete results are presented in Figure 20.

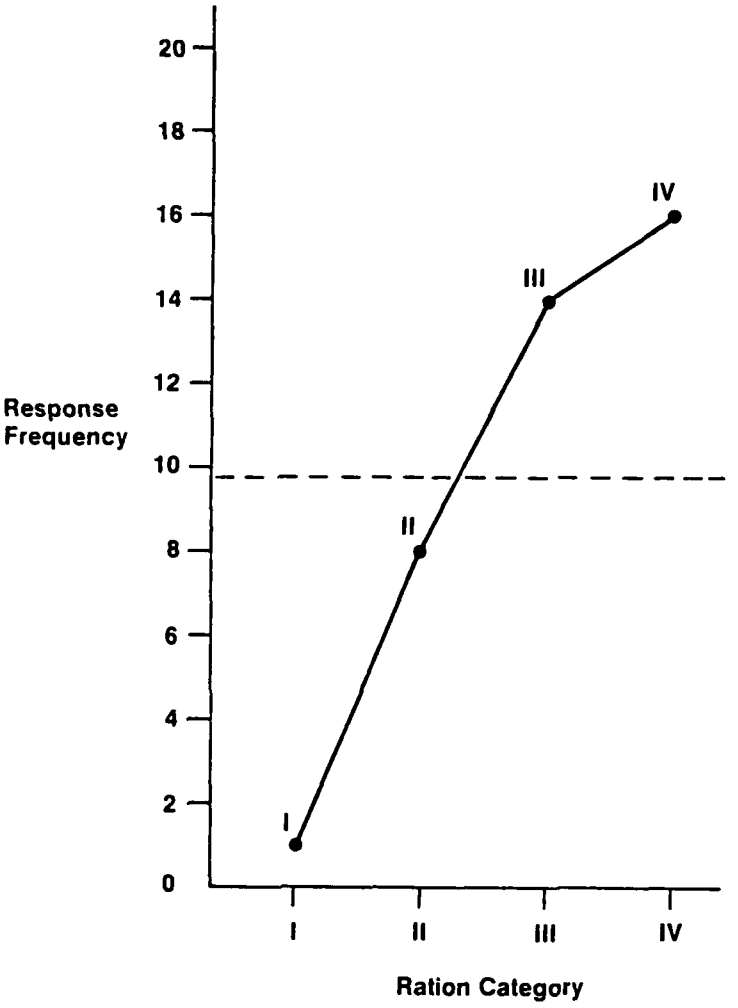

Figure 20 — Sensory Variety Response

Ration Characteristics Summary

After reviewing the ration characteristics individually, several conclusions may be drawn.

Overall, the most important ration characteristic was acceptability, which was selected as the most important characteristic in categories II, III, and IV. In category I, respondents ranked acceptability as the third most important characteristic, its lowest ranking. Respondents could select a characteristic a maximum of 80 times. The characteristic acceptability was selected 74 times, or 93% of the maximum. Using the standard deviation of 1.5 as a measure of dispersion, ratings for acceptability were the most evenly distributed.

The second most important ration characteristic was low weight and cube. Respondents selected low weight and cube 47 times, for a response rate of nearly 59%. The responses were concentrated in categories I and II; thus, the standard deviation of 7.7 indicates that the ratings of the low weight and cube characteristic were not evenly distributed.

The third most important ration characteristic was ease of use. Respondents selected ease of use 41 times, for a response rate of approximately 51%. Once again, responses were concentrated in categories I and II, producing a standard deviation of 6.9, or a less than even dispersion.

The fourth most important ration characteristic was nutritionally tailored diets. Respondents selected this characteristic 40 times, for a response rate of 50%. Although responses were concentrated in categories III and IV, a 3.7 standard deviation indicates that selections were close to being evenly dispersed.

The fifth most important ration characteristic was sensory variety, which respondents selected 39 times, for a response rate of nearly 49%. Once again, responses were concentrated in categories III and IV. A standard deviation of 5.9 means that the selections were not evenly dispersed.

These results seem to indicate that there is no universal formula for producing optimal rations for all combat soldiers in every situation.

The only characteristic selected as among the five most important for all four categories was acceptability. The characteristic of repeated consumption was selected as among the most important in three categories, even though it ranked sixth in cumulative selections. The following five characteristics were selected as among the most important in two categories: ease of use, low weight and cube, easily decontaminated, sensory variety, and nutritionally tailored diets. The following three characteristics were each selected as among the most important in one category: performance enhancement, extended shelf life, and high producibility. Only one characteristic, low acquisition cost, was never selected as among the five most important. Results are summarized in Figure 21.

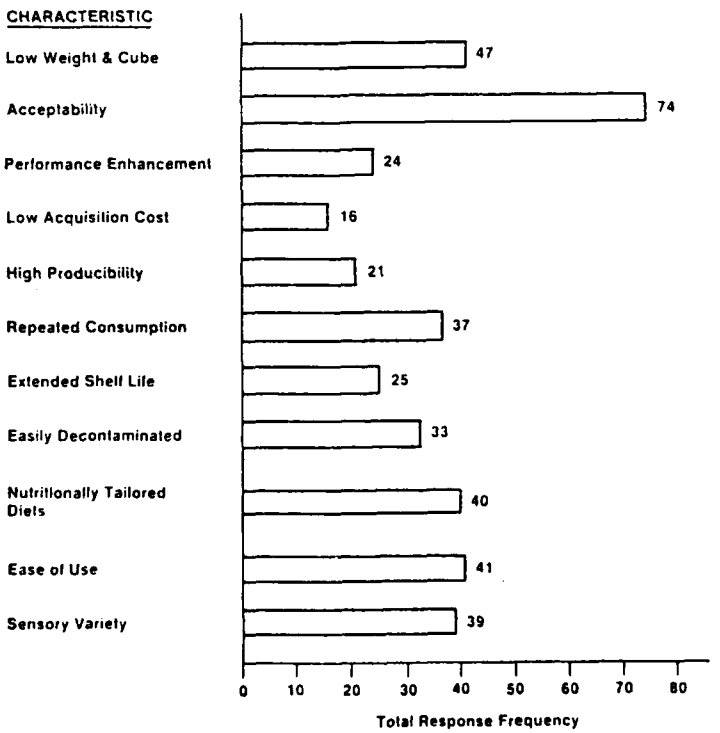

Figure 21 — Cumulative Response Frequencies

Allocating Research and Development Effort

The second part of the third survey asked respondents how research and development effort should be allocated from now until the year 2000. Respondents could allocate effort into the following areas: improving existing ration systems, new ration development, and basic food research. Respondents were instructed to write the percentage of effort that should be allocated to each of these areas.

Respondents selected new ration development to receive the highest allocation of research and development followed by improving existing rations, and basic food research. The small percentage difference between these areas indicates that a balanced effort among these areas is the best approach in military ration research and development programs. Responses are summarized in Figure 22 and in Table 16.

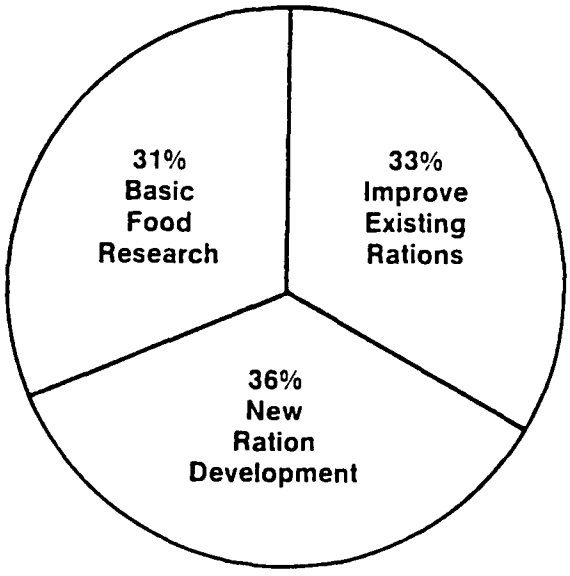

Figure 22 — Suggested Amount of R&D Emphasis by Research Area

TABLE 16. Allocation of Research and Development Effort.

Improve Existing Rations	New Ration Development	Basic Food Research
40	50	10
30	55	15
40	40	20
30	40	30
60	30	10
0	10	90
20	40	40
30	50	20
20	30	50
20	40	40
35	35	30
50	25	25
33	30	40
33.3	33.3	33.3
20	40	40
80	10	10
15	55	30
25	50	25
50	20	30
631.3	683.3	588.3

Improve Existing Rations $\frac{631.3}{19} = 33\%$

New Ration Development $\frac{683.3}{19} = 36\%$

Basic Food Research $\frac{588.3}{19} = 31\%$

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The following conclusions can be drawn from the results of this survey.

- Acceptability is the most important ration characteristic in all categories of food service.

- The most important characteristics of a ration system for individual troops in intense levels of combat without resupply for up to 5 days are as follows, in descending order of importance: ease of use, low weight and cube, acceptability, performance enhancement, and easily decontaminated.

- The most important characteristics of a ration system for individual troops in moderate levels of combat for up to 4 weeks with 3 to 5 days resupply are as follows, in descending order of importance: acceptability, low weight and cube, ease of use, repeated consumption, and easily decontaminated.

- The most important characteristics of a ration system for individual or group use in low levels of combat for extended periods with established resupply are as follows, in descending order of importance: acceptability, sensory variety, nutritionally tailored diets, repeated consumption, and extended shelf life.

- The most important characteristics of a ration system for group use providing a hot meal in stable environments for extended periods are as follows, in descending order of importance: acceptability, sensory variety, high producibility, nutritionally tailored diets, and repeated consumption.

Recommendations

Based on the aggregate survey results, the following recommendations are made:

- customer acceptance should be integral in all new ration development programs;

- ration characteristics should be prioritized according to the intended user of the ration, intensity of action, duration, and resupply;

- rations should become mission specific with nutritional levels optimized to anticipated levels of physical activity within logistic constraints; and

- allocation of research and development effort should be balanced between new ration development (36%), improving existing rations (33%) and basic food research (31%).

APPENDIX A.

Trends in Combat Ration Development: Survey I

TRENDS IN COMBAT RATION DEVELOPMENT

PLEASE READ QUESTIONS 1-12 CAREFULLY, THEN CHECK A BOX CORRESPONDING TO WHEN YOU THINK EACH EVENT WILL MOST LIKELY OCCUR.

		Never	1985 to 1989	1990 to 1994	1995 to 1999	2000 +
1.	A new food additive plays a dominant role in the preservation of combat rations.	[]	[]	[]	[]	[]
2.	Highly motivated soldiers view rations as "fuel for the battle" negating the need for highly acceptable foods.	[]	[]	[]	[]	[]
3.	Freeze dehydration becomes the primary means of producing shelf stable foods.	[]	[]	[]	[]	[]
4.	All combat rations are highly engineered and do not resemble the common foods of today.	[]	[]	[]	[]	[]
5.	Irradiation becomes a widely used method of producing shelf stable foods.	[]	[]	[]	[]	[]
6.	A newly developed drug substantially lowers the daily requirement for calories.	[]	[]	[]	[]	[]
7.	Aseptic packaging becomes the preferred method of producing both liquid and particulate shelf stable products.	[]	[]	[]	[]	[]
8.	The tray pack becomes obsolete for consolidated field feeding.	[]	[]	[]	[]	[]
9.	New technology permits refrigeration/freezing to become the dominant means to preserve combat rations.	[]	[]	[]	[]	[]
10.	Concentrated nutrient tablets replace daily meals.	[]	[]	[]	[]	[]
11.	Reducing weight and cube is no longer the focus of research and development efforts for combat rations.	[]	[]	[]	[]	[]
12.	Food consumption in NBC environments becomes the driving force behind future ration development.	[]	[]	[]	[]	[]

	Never	1985 to 1989	1990 to 1994	1995 to 1999	2000 +
13. Behavior modifying substances are incorporated into rations to improve battlefield performance.	[]	[]	[]	[]	[]
14. Technological advances make the MRE ration obsolete.	[]	[]	[]	[]	[]
15. Battlefield water supply precludes the use of dehydrated rations in field feeding.	[]	[]	[]	[]	[]

* * * * * * * * * * * *

PLEASE ANSWER THE REMAINING QUESTIONS BY BRIEFLY STATING YOUR OPINIONS.

16. What will be the dominant preservation method for future combat rations ?

17. What will be the most significant contribution of biotechnology to military ration development ?

18. Please list three essential characteristics of a successful new combat ration.

19. Please list three essential characteristics of a successful new commercial food product.

20. What additional areas would you like to see addressed in subsequent surveys ?

WHEN YOU HAVE COMPLETED YOUR SURVEY, PLEASE DROP IT OFF IN ROOM R-120, OR CALL X-4504 OR X-4252 TO HAVE YOUR SURVEY PICKED UP. YOU WILL RECEIVE A FOLLOW-UP SURVEY WITHIN TEN DAYS. THANK YOU FOR YOUR COOPERATION.

NAME, LAB/OFFICE, EXTENSION (OPTIONAL) _____ _____ _____

APPENDIX B.

Trends in Combat Ration Development: Survey II

TRENDS IN COMBAT RATION DEVELOPMENT PART II

1. For the period from 1985-2000, which of the following do you think should be the focus of combat ration research & development ? Check three.

Reducing weight/cube	[]	Extended shelf life	[]
Factors of consumption	[]	Simple decontamination	[]
Performance enhancement	[]	Producibility	[]
Low cost	[]	NBC consumption	[]
Special nutritional needs	[]	Other _____	[]

2. A majority of respondents to the first survey indicated that rations of the future may contain substances to improve battlefield performance. Select three of the following that you see as possible through ration formulation:

Stress control	[]	Psychological conditioning	[]
Fear reduction	[]	Increased endurance	[]
Improved sleep	[]	Mental alertness	[]
Digestive aids	[]	Other _____	

3. Of those responding to the first survey, 77 percent indicated that all combat rations after 1990 would be highly engineered and not resemble the common foods of today. Indicate on the line below how long a highly engineered food item would be readily consumed in a future combat situation.

DAYS

0 5 10 15 20 25 30 60 90

4. Eighty two percent of those responding to the first survey indicated that irradiation will become widely used to produce shelf stable foods after 1990, with fifty percent specifying wide use from 1995 -1999. When will irradiation for commercial sterilization be used in combat rations?

1990-94 [] 1995-99 [] 2000+ []

5. Many respondents, 59 percent, indicated that the MRE will remain viable until the early 21st century. Which characteristic of the MRE is the key to its longevity ?

6. Fifty-five percent of the responses to the first survey indicated that the tray pack for consolidated field feeding purposes would be obsolete after the year 2000. What characteristic of the tray pack feeding concept will allow it to remain viable well into the 21st century ?

7. Sixty eight percent indicated that reducing weight and cube would remain the focus of military ration R&D. When will the tradeoff between optimal caloric density and acceptability/consumption for combat rations be achieved?

1985-89 [] 1990-94 [] 1995-99 [] 2000+ []

8. Respondents to the first survey were divided as to whether or not future soldiers would view rations as "fuel for the battle", thus negating the need for highly acceptable foods. What is the probability of success for a program designed to convince future combat soldiers to accept this view by 2000?

9. When asked to name a dominant preservation/processing technique for future combat rations, responses to the first survey were as follows:

Dehydration (other)	18%	No dominant method	15%
Freeze dehydration	15%	Thermal	7%
Low water activity	15%	Aseptic packaging	7%
Irradiation	15%	Additives/chemicals	7%

From the list below, select four preservation methods that will be the most widely used for future combat rations.

Freeze dehydration	[]	Thermal (cans)	[]
Other dehydration	[]	Thermal (pouches)	[]
Low water activity	[]	Aseptic packaging	[]
Irradiation	[]	New/novel methods	[]
Additives/chemicals	[]	Other _____	[]

10. What major issues concerning water on the future battlefield must be addressed in new ration concepts?

WHEN YOU HAVE COMPLETED YOUR SURVEY, PLEASE DROP IT OFF IN ROOM R-120 OR USE THE ATTACHED MESSENGER ENVELOPE. YOU WILL RECEIVE THE FINAL SURVEY IN ABOUT TEN DAYS. THANK YOU FOR YOUR COOPERATION.

APPENDIX C.

Trends in Combat Pation Development: Survey III

TRENDS IN FOOD TECHNOLOGY PART III

I. Four categories of food service have been identified for Army 21 field feeding. For each category check the five most important characteristics that should be considered in R&D efforts.

Category One: A ration system for individual troops in intense combat without resupply for up to five days.

Low weight/cube	[]	Extended shelf life	[]
Acceptibilty	[]	Easily decontaminated	[]
Performance enhancement	[]	Nutritionally tailored diets	[]
Low acquisition cost	[]	Ease-of-use	[]
High producibility	[]	Sensory variety	[]
Repeated consumption	[]		

Category two: A ration system for individual troops in moderate levels of combat for up to four weeks with 3 to 5 day resupply.

Low weight/cube	[]	Extended shelf life	[]
Acceptibility	[]	Easily decontaminated	[]
Performance enhancement	[]	Nutritionally tailored diets	[]
Low acquisition cost	[]	Ease-of-use	[]
High producibility	[]	Sensory variety	[]
Repeated consumption	[]		

Category Three: A ration system for individual or group use in low levels of combat for extended periods with established resupply.

Low weight/cube	[]	Extended shelf life	[]
Acceptibility	[]	Easily decontaminated	[]
Performance enhancement	[]	Nutritionally tailored diets	[]
Low acquisition cost	[]	Ease-of-use	[]
High producibility	[]	Sensory variety	[]
Repeated consumption	[]		

Category Four: A ration system for groups featuring a hot meal in stable environments for extended periods.

Low weight/cube	[]	Extended shelf life	[]
Acceptibility	[]	Easily decontaminated	[]
Performance enhancement	[]	Nutritionally tailored diets	[]
Low acquisition cost	[]	Ease-of-use	[]
High producibility	[]	Sensory variety	[]
Repeated consumption	[]		

II. Considering the above food service categories what percent of R&D effort should be allocated to each of the following areas from now until the year 2000?

Improving existing ration systems____

New ration development ____

Basic food research ____